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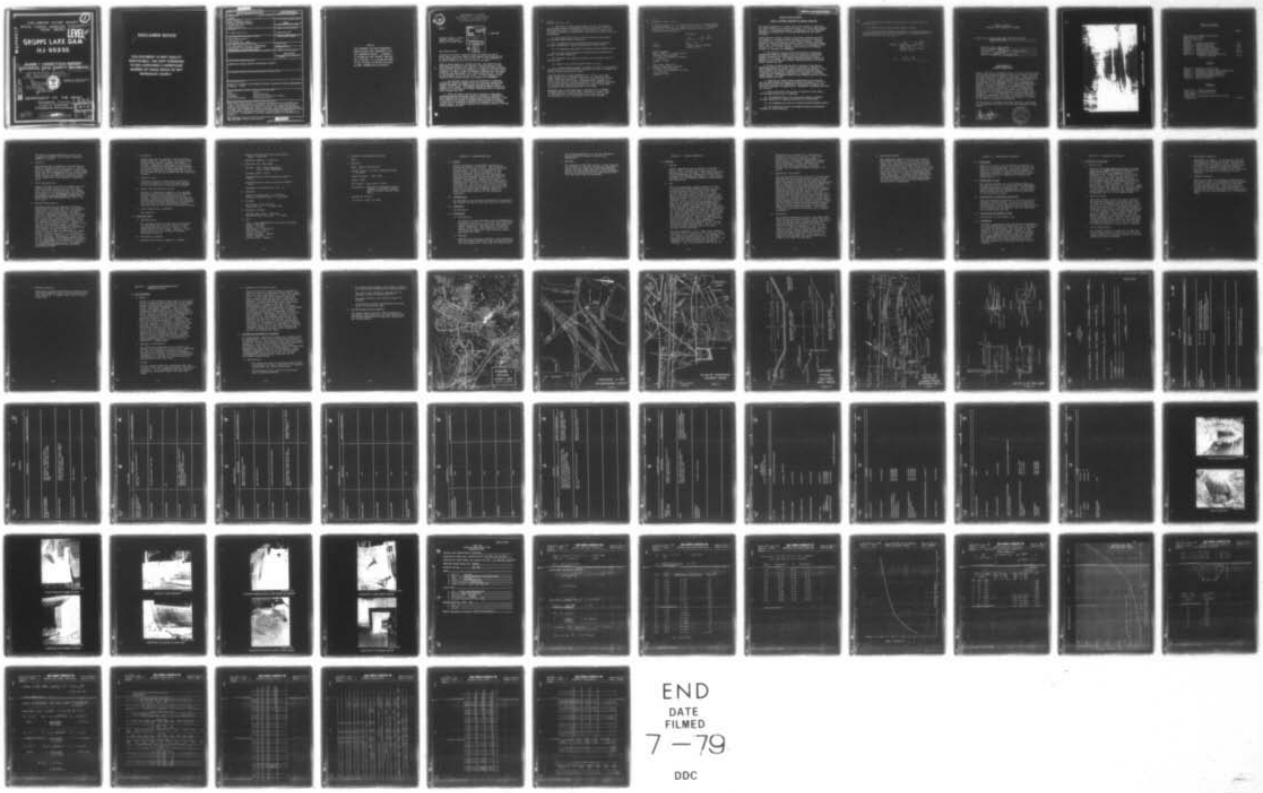

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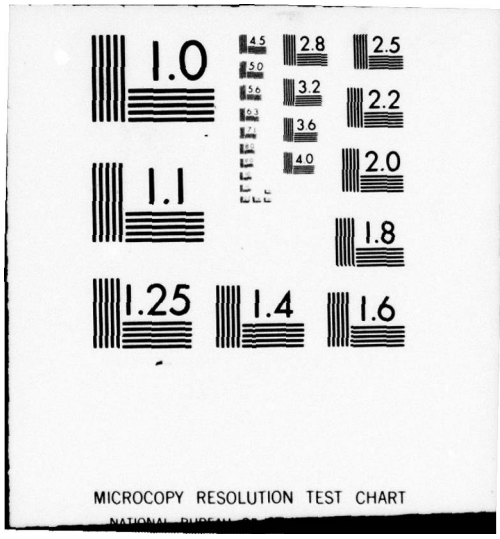
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BACK CREEK, MERCER COUNTY
NEW JERSEY

LEVEL II

GROPPS LAKE DAM
NJ 00235

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM.

Gropps Lake Dam (NJ00235). Delaware River Basin, Back Creek, Mercer County, New Jersey. Phase 1 Inspection Report.

(15) DACW61-78-C-0124
(9) Final Report,
(10) F. Keith Jolls

Approved for public release; distribution unlimited

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

(12) 75p.
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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dams	Safety
Spillway	Visual Inspection
Embankments	National Dam Inspection Act Report
Structural Analysis	Gropps Lake Dam, N.J.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
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CUSTOM HOUSE - 2 D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-D

15 MAY 1979

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, New Jersey 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Gropps Lake Dam in Mercer County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Gropps Lake Dam, initially listed as a high hazard potential structure but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in poor overall condition. The dam's spillway is considered inadequate since 38 percent of the Spillway Design Flood - SDF - would overtop the dam. (The SDF, in this instance, is the 100 year flood.) To insure adequacy of the structure, the following actions, as a minimum, are recommended:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies within six months from the date of approval of this report. Any remedial measures necessary to insure the adequacy of the spillway and to prevent overtopping should be initiated within calendar year 1980.

b. Within six months from the date of approval of this report, engineering studies and analyses should be performed to determine the dam's embankment and foundation condition and structural stability. This should include test borings to determine material properties relative to stability and seepage and installation of piezometers to facilitate seepage studies. Any remedial measures found necessary should be initiated within calendar year 1980.

c. Along with the safety related considerations of the existing dam, the socio-economic alternatives discussed in paragraph 7.1.d of the report should be given due consideration, particularly in light of the New Jersey Department of Transportation's condemnation proceedings involving the structure.

d. Within three months from the date of approval of this report, the following actions should be completed:

(1) The downstream edge of the splash apron should be protected (at least temporarily) by dumping riprap into the stilling basin.

(2) The undermined apron should be backfilled and/or pressure grouted.

(3) The eroded areas between the wingwalls should be refilled and provided with slope protection.

(4) The sluice gate should be repaired and its entrance cleared of debris and silt.

(5) Cracks in the concrete spillway should be patched.

(6) The owners should institute operations and maintenance procedures in conjunction with Municipal and State Authorities and develop checklists for periodic inspections and record keeping.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman Frank Thompson, Jr. of the Fourth District. Under the provisions of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a resonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

NAPEN-D
Honorable Brendan T. Byrne

An important aspect of the Dam Safety Program will be the implementation of the recomendations made as a result of the inspection. We accordingly request that we be advised of proposed action taken by the State to implement our recommendations.

Sincerely,

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

1 Incl
As stated

Copies furnished:
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Division of Water Resources
N. J. Dept of Environmental Protection
P. O. Box CN029
Trenton, NJ 08625

John O'Dowd, Acting Chief
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Trenton, NJ 08625

GROPPS LAKE DAM (NJ00235)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 5 January 1979 by Louis Berger and Associates Inc. under contract to the State of New Jersey. The State, under agreement with the U. S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Gropps Lake Dam, initially listed as a high hazard potential structure but reduced to a significant hazard potential structure as a result of this inspection, is judged to be in poor overall condition. The dam's spillway is considered inadequate since 38 percent of the Spillway Design Flood - SDF - would overtop the dam. (The SDF, in this instance, is the 100 year flood.) To insure adequacy of the structure, the following actions, as a minimum, are recommended:

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(5) Cracks in the concrete spillway should be patched.

(6) The owners should institute operations and maintenance procedures in conjunction with Municipal and State Authorities and develop checklists for periodic inspections and record keeping.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 7 May 79

PHASE I REPORT
NATIONAL DAM INSPECTION PROGRAM

Name of Dam Gropps Lake Dam Fed ID# NJ 00235
and NJ ID# 28-10

State Located New Jersey
County Located Mercer
Coordinates Lat. 4011.2 - Long. 7441.4
Stream Back Creek
Date of Inspection 5 January 1978

ASSESSMENT OF GENERAL CONDITIONS

Gropp's Lake Dam is assessed to be in a poor overall condition as the downstream splash apron and wingwall footings are undermined and in danger of collapse. Overtopping or collapse would not greatly increase the downstream danger to life or property and the hazard classification is recommended to be downgraded from high to significant. Remedial actions recommended to be undertaken very soon include 1) placing riprap in the downstream stilling basin, 2) backfill and pressure grout the undermined splash apron, 3) backfill the eroded zones behind the wingwalls and add slope protection, and 4) repair the sluicegate. It is recommended that further engineering studies be undertaken very soon to ascertain the continued stability and to evaluate the effects of removal of the dam or alternative solutions.

The dam has an inadequate spillway capacity, being able to accommodate only 37% of the 100 year frequency design flood.

F. Keith Jolls P.E.
Project Manager

OVERVIEW OF GROPPS LAKE DAM

DECEMBER, 1978

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM
NAME OF DAM GROPPS LAKE DAM FED. ID# NJ 00235

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority

This report is authorized by the Dam Inspection Act, Public Law 92-367, and has been prepared in accordance with Contract FPM-36 between Louis Berger & Associates, Inc. and the State of New Jersey and its Department of Environmental Protection, Division of Water Resources. The State, in turn, is under agreement with the U.S. Army Engineer District, Philadelphia, to have this inspection performed.

b. Purpose of Inspection

The purpose of this inspection is to evaluate the structural and hydraulic condition of the Gropps Lake Dam and appurtenant structures, and to determine if the dam constitutes a hazard to human life or property.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances

Gropps Lake Dam is an irregular earth structure with a centrally located, reinforced concrete spillway. The right embankment section is about 150 feet long, terminating at the shoulder line of Route 524, (South Broad Street). The spillway consists of a 50 foot wide narrow crested weir with a sloping concave downstream slab which connects to a concrete splash apron. A 36 inch RCP outlet which is regulated by a stem operated gate is located at the right end of the spillway. The left embankment section is about 285 feet long and terminates at the steeply rising natural slopes bordering the reservoir. The slopes of

the heavily wooded embankment sections are variable but appear to have been originally graded to 1.5H:1V.

b. Location

Gropps Lake Dam is located in the Township of Hamilton, Mercer County, New Jersey. Gropps Lake is formed by the impoundment of Back Creek about 400 feet downstream from its passage under Route 524 and is immediately south of the South Broad Street interchange of Interstate Route I-195 (Interstate I-195 presently terminates here).

c. Size Classification

Gropps Lake Dam is 25 feet in height and has a maximum storage capacity of 549 acre feet. Thus, this dam has been placed in the small size category in accordance with the criteria promulgated in the Recommended Guidelines for the Safety Inspection of Dams (height less than 40 feet and impoundment less than 1,000 acre-feet).

d. Hazard Classification

Although there are no habitable structures downstream from Gropps Lake Dam, the proposed construction of I-195 south of its present terminus at South Broad Street includes a connector road whose embankment and retaining wall will ultimately be within 50 feet of the face of the dam. Further downstream, Route 206 bridges Crosswick Creek immediately below its confluence with Back Creek. Failure of the dam could possibly result in damage to both existing and proposed highway structures. Additionally, the environmentally undisturbed area between the dam and Route 206 is unofficially utilized as parklands for nature studies, hiking, etc. so as to constitute a slight potential hazard to loss of life should the dam collapse. Accordingly, Gropps Lake Dam is recommended to be downgraded and placed in the significant hazard potential category in accordance with the criteria promulgated in the Recommended Guidelines for the Safety Inspection of Dams.

e. Ownership

Gropps Lake Dam is presently owned by Messers. Andrew Gropp Jr, Walter Gropp, and Harry Gropp, 46 Whitehorse Avenue, Trenton, New Jersey. However, according to Municipal and State DOT sources, condemnation proceedings are presently in process which may transfer ownership to the New Jersey Department of Transportation as part of the right-of-way procurement for the Interstate highway.

f. Purpose of Dam

Although originally constructed to provide a source of power for a mill, the lake and dam is now used solely for recreational purposes.

g. Design and Construction History

Nothing is known with respect to the original design or construction although it is believed to have been built around the turn of the century. Repair plans prepared by the Hamilton Township Engineering Department in 1970 indicate some of the structural dimensions and elevations, but are based on field measurements taken at that time and not the original construction plans.

h. Normal Operational Procedures

See Section 4.

1.3 PERTINENT DATA

a. Drainage Areas

The drainage area of Gropps Lake Dam consists of 7.95 square miles of low relief, rolling topography which is rural in nature in the upper reaches of Back Creek. However, in the vicinity of the lake, extensive suburban development exists.

b. Discharge at Damsite

Maximum known flood at damsite: Unknown

Design discharge (DOT Road plans design data): 1,100 cfs

Spillway capacity: 1,900 cfs

c. Elevation (ft. above MSL)

Top Dam - +29.7 (left embankment)
+34.0 (right embankment)

Spillway crest - +24.6

Upstream portal invert diversion conduit - +8.8

Downstream portal invert diversion conduit - +8.2

Streambed at centerline of dam - +5

d. Reservoir

Length of maximum pool - 8,000 feet
Length of recreation pool - 4,000 feet

e. Storage

Top of dam - 549 acre feet
Recreation pool - 211 acre feet

f. Reservoir Surface

Top dam (max. pool) - 98 acres
Recreation pool (spillway) - 41 acres

g. Dam

Type - Earth embankment with concrete spillway
Length - 485 feet
Height - 25 feet
Top Width - 15 feet (avg.)
Side Slopes - 1.5H:1V
Zoning - Unknown
Impervious Core - Unknown
Cutoff - Unknown
Grout curtain - Unknown

h. Diversion and Regulating Tunnel

None

i. Spillway

Type - Narrow crested weir

Length of weir - 50 feet (effective width = 49 feet)

Crest elevation - +24.6 MSL

Gates - None

U/S Channel - Main body of lake

D/S Channel - Meandering bifurcated stream channel in a deeply incised, heavily-wooded, natural flood plain

j. Regulating Outlets

36" RCP at invert +8.2 MSL

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

Little information is available regarding the engineering details of design. The structure is over 80 years old and is in an advanced stage of deterioration. As-built information of the overall dimensions and an evaluation of the spillway geometric conditions are indicated on Drawing A-359 prepared by the Hamilton Township Engineering Department (dated 16 June 1970). However, these did not disclose any design data regarding the foundation conditions or details of construction. The soils in the vicinity consist of recent alluvium and are mainly silts and sands with some clay and gravel deposits increasing in content with depth. The irregular mantle is mainly Quaternary deposits of the Pennsauken formation.

2.2 CONSTRUCTION

No information was available regarding the contractor who erected the dam or the exact date of construction.

2.3 OPERATION

See Section 4.

2.4 EVALUATION

a. Availability

In view of the dam assessment and recommendations contained in Section 7, it is felt that sufficient engineering data is available for conducting the Phase I inspection and evaluating the overall safety of the dam. The exhaustive search conducted by the inspection team failed to locate any additional data.

b. Adequacy

Referring to the above paragraph, the engineering data is deemed adequate for the analysis required for this inspection. This does not connote that

the long-term safety is in any way warranted unless immediate remedial measures are undertaken.

c. Validity

The validity of the 1970 as-built survey compiled by the Hamilton Township Engineering Department agrees with the inspection team's measurements and is not challenged although further embankment erosion and deterioration has taken place since the time their work was completed.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

a. General

Visual inspections were conducted on January 5 and 11, 1979 at which time a small flow was observed over the spillway. The overall condition of the embankment was assessed as satisfactory although some seepage was observed. The concrete spillway is in an advanced stage of deterioration (See Section 6).

b. Dam

The right embankment extends roughly 150 feet to the edge of South Broad Street and is of an irregular shape, being in most areas almost 10 feet above the spillway crest (El. 24.6). Much of the upper area is used as a parking lot. There is serious erosion of the backslope zone immediately next to and below the right spillway abutment, where a cavity 10 to 15 feet wide has been cut out since the 1970 measurements were made by the Township Engineering Department. There are roadway storm drains exiting from the north through the embankment toe which contribute to the channel erosion and deep (4'+) gullies are cut into the backslopes by surficial runoff from the nearby streets and parking area. The slopes are very steep and appear to be collapsing at an accelerating rate. There are numerous large trees in the vicinity, and in several locations their root systems have been undermined. Several wet areas were observed at the toe but no flowing water was observed. There is a substantial amount of debris along the lower portion of the backslopes.

The left embankment is at a much lower average elevation (+29.7) and has a crest width as narrow as 6 feet in its central area. The embankment is also severely eroded in back of the spillway wingwalls and has extensive soft wet areas at the backslope toe (with significant seepage in evidence). The leaves covering the ground are

discolored by an orange silt, indicating a movement of fines from the soil. The backslopes are in a more uniformly graded condition but are heavily wooded with several large stumps in evidence. Immediately below the left abutment, a drainage swale has eroded down the backslope due to surface run-off from the higher natural terrain to the south.

c. Appurtanent Structures

The old concrete spillway crest is in fairly good alinement but the concave overflow slab, splash apron and parallel wingwalls are undercut, and their continued stability is extremely questionable. Most of the stem of the right wing has broken off and has toppled into the downstream channel. There are numerous cracks in the various elements remaining in position and the concrete is deteriorated practically beyond repair. The left wingwall has not fallen over but has broken free from the spillway end pier and the footing toe is undermined. The apron splash slab is also undermined and has settled and tilted out of alinement while separating from the concave overflow. There is deep erosion behind both downstream wingwalls. What is actually supporting the spillway crest could not be visually determined. The controls of the 36" gate valve are missing and it appears inoperable.

d. Reservoir

The upstream reservoir has steep but stable banks which are quite heavily wooded. About 450 feet north of the dam, the lake passes under the existing South Broad Street bridge (which has an adequate hydraulic length of over 60 feet but only 3 to 5 feet of freeboard). Most of the reservoir lies north of this bridge. The lake appears heavily silted around the perimeter and at the face of the dam and there are considerable debris deposits in many areas. In front of the spillway, the silted lake bed is within 3 to 5 feet of the crest.

e. Downstream Channel

The downstream channel is fairly well defined after departing from a large natural stilling basin that a combination of spillway discharge, roadway culverts and overland flow (from the north) have scoured out of the natural river bed. The creek takes an abrupt turn to the left, after exiting from this pool and continues unimpeded about 2000 feet west where it discharges into Crosswicks Creek. It appears that extreme high tides occasionally reach the foot of the dam. As shown on Figures 2-4, the downstream channel will be relocated when the future Interstate construction is undertaken.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

There are no longer any operational procedures in effect at Gropps Lake Dam. The sluice gate at the spillway is inoperable due to missing controls and, since the ownership of the dam may be presently undergoing litigation, there is no agency or party apparently willing to undertake the operational responsibility.

4.2 MAINTENANCE OF DAM

The dam and spillway are in an advanced state of deterioration and it is obvious that no maintenance has been performed in several years. The extensive repairs planned by the Township in 1970 have never been executed and the deterioration has continued in the intervening years.

4.3 MAINTENANCE OF OPERATING FACILITIES

The only regulating component at the dam is the 36" diameter concrete sluice. Parts of the operating mechanism are missing and the concrete housing for the controls is in an advanced state of deterioration. No maintenance of this facility has been performed for a considerable period.

4.4 DESCRIPTION OF WARNING SYSTEM

None exists at the present time.

4.5 EVALUATION

The lack of maintenance and operational procedures is a serious deficiency at Gropps Lake Dam. Due partly to a lack of maintenance, the spillway has deteriorated to the point where the integrity of the structure is now questionable. Moreover, indications of an impending failure might go unnoticed due to the apparent lack of monitoring. Further, the inoperative sluice gate precludes lowering the water level to a safe elevation even if an imminent failure were noted and remedial actions required.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 ELEVATION OF FEATURES

a. Design Data

Based on the Recommended Guidelines for Safety Inspection of Dams, the dam at Gropps Lake is small in size and of significant hazard. Accordingly the design flood is the 100-year frequency event. Inflow to the reservoir for the 100-year storm was computed utilizing precipitation data from Technical Publication 40 and NOAA Technical Memorandum NWS-HYDRO. 35 by the HEC-1 computer program. This gave a peak inflow to the reservoir of 6,290 cfs. When routed through the reservoir the peak was reduced to 5,180 cfs. The spillway has a maximum discharge capacity of 1,900 cfs and therefore can accommodate only 37% of the design flood.

b. Experience Data

There are neither records available concerning the hydraulics/hydrology for Gropps Lake Dam, nor were any streamflow records located. From a review of the Interstate roadway construction plans (see Figures 2-5), the relocated channel required by the future construction contemplated a 30 feet channel (with 2:1 side slopes) built on a 0.3% gradient. This channel would have a maximum capacity of approximately 5,400 cfs which is slightly more than the routed 100 year value presented above. However, the road plans indicated a design discharge over the spillway of only 1100 cfs which is only 21% of the SDF. The design frequency of this flood is unknown.

c. Visual Observations

The spillway appears to function satisfactory as an uncontrolled overflow, and as previously stated, there are no hearsay records of the dam having ever been overtopped.

d. Overtopping Potential

Although it is unknown if the dam has ever been overtopped the spillway is clearly not capable of transmitting the design flood. However, the potential for overtopping, although substantial in view of the hydraulic analysis contained herein, is not of major concern to the inspection team when compared to the condition of the spillway.

e. Drawdown Potential

There are no means of drawing the lake down at the present time. The abandoned 36-inch concrete intake (if repaired) could draw the lake down in approximately 2 days. The inlet for this sluice gate extends over 40 feet upstream from the spillway and could possibly be plugged, as it appears to have been abandoned for a considerable time.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations

Summarizing Section 3, the lower portions of the spillway apron and wingwalls are in the danger of imminent collapse. Since the 1970 review of conditions by the Hamilton Township Engineering Department, the deterioration has advanced; especially at the right end of the spillway. The erosion of the downstream embankment behind the toppled wingwall has continued up to the spillway axis and an overtopping might breach the embankment in this area. The only safeguard here is the high crest elevation, i.e., the left (lower) embankment would be overtopped first. The downstream edge of the apron slab is completely exposed with the channel bed 3 to 4 feet below the irregular invert (El. 8.6±). Only by driving a row of sheeting and pressure grouting the apron and wingwall foundations can the outfall end be salvaged, and even this solution might be considered uneconomical from an engineering cost/justification standpoint.

The remainder of the true dam embankment exists mainly on the left of the spillway and except for the seepage and dead tree root systems, appears to be in a fairly stable condition except for the irregularity of the backslopes.

b. Design and Construction Data

As no design data was available relating to the concrete spillway, little can be deduced about the structural stability, except that the crest exhibits only minor differential settlement and the 18 inch top width does not show any major evidences of failure. Further investigation and in-situ tests of the foundation would be required to verify, with any reliability, the long-term stability. The spillway wall is believed to be braced with buttresses in some fashion and is, in all probability, founded on piling (but this is completely conjectural).

No data was located concerning the original construction.

c. Operating Records

No formal records exist. The 1970 renovation plans prepared by Hamilton Township were as a result of an order from the Department of Environmental Protection which considered the dam to be in a serious danger of breaching. The Township's subsequent investigation revealed that there was no danger and no further action was taken.

d. Post Construction Changes

There have been no modifications to the dam in recent years. In 1975, in conjunction with the Interstate I-195 construction (and possibly for condemnation proceedings input) the NJDOT Bureau of Structural Design prepared estimates of construction cost for repairing the dam. Their figures are presently of little value in view of cost escalation and the continued deterioration. It is not known exactly why these estimates were prepared or if this work was actually contemplated to be undertaken. The exact remedial work they envisioned is unknown.

As indicated on the attached plates of NJDOT road plans, the future construction of I-195 southwest of Broad Street contemplates the installation of a steel sheet piling wall at the foot of the roadway embankment of South Broad Street (E.B.) which is some 50 feet below the spillway. Further, over 1000 feet of downstream channel are planned to be relocated along the south limits of the Interstate right-of-way. Although no date is presently projected for the construction of the highway, the continued possibility of the dam's collapse could have major economic effects on the future roadway construction. For example, if the dam were removed, the deletion of several hundred feet of steel sheet-piling wall would produce major cost savings - possibly several times the cost of attempting to repair the dam structure. Certainly, all the facets of this interrelationship should be examined in future evaluations.

e. Seismic Stability

Experience indicates that dams in Seismic Zone 1 will have adequate stability under dynamic loadings conditions if stable under static loading conditions.

SECTION 7 - ASSESSMENTS/RECOMMENDATIONS/ REMEDIAL ACTIONS

7.1 DAM ASSESSMENT

a. Safety

Subject to the inherent limitations of the Phase I visual inspection and the fact that little cogent design or construction information is available, Gropp's Lake dam is assessed to be in a poor overall structural condition. The spillway is inadequate hydraulically, being able to accommodate only 37% of the 100 year frequency design flood, although overtopping of the embankment is not considered as serious a hazard as the possible breaching of the zones immediately behind the spillway wingwalls. There is little that can be done economically to increase the spillway capacity. A breaching behind the right spillway abutment or further collapse of the downstream wingwalls and apron slab is deemed to be a far more serious threat and this condition should be repaired if the dam is to be maintained in its present position. Because there is minimal downstream hazard to human life or property should the dam collapse, its hazard classification is recommended to be downgraded to significant.

b. Adequacy of Information

The information gathered for this Phase I is deemed to be adequate for this initial inspection but does not guarantee continued stability unless certain remedial repairs are immediately undertaken. No surveys or inspections have been recorded since 1970 and the dam has undergone deterioration since that time.

c. Urgency

Further studies should be undertaken very soon in view of the dam's hazard assessment and overall condition. It is recommended that the remedial measures be undertaken within the same time-frame.

d. Necessity for Further Study

Further studies are unquestionably required at this site but are viewed as possibly being undertaken in a two-fold procedure. Under the purview of P.L. 92-367, additional studies should be made to assess what can be done to effectuate assurance of continued safety to human life and property, possibly with short-range objectives. Concurrently, it appears that due to the deteriorated condition of the dam, the NJDOT, in conjunction with the Department of Environmental Protection, should undertake a more in-depth socio-economic analysis to determine if other environmentally acceptable solutions might prove more feasible. (For example, building a new spillway at the South Broad Street bridge and removing the dam and lower portion of the lake could be analyzed from a cost and environmental standpoint.) Consequently, the remedial repairs set forth below could be considered of a somewhat temporary nature and if the final decision is to attempt to preserve the dam, would undoubtedly be of a more extensive nature.

7.2 RECOMMENDATIONS/REMEDIAL MEASURES

As stated above, additional engineering studies should be implemented in view of the deteriorated condition of the dam and its juxtaposition with Interstate I-195. Further, in view of the present condemnation procedures reportedly in process for highway right-of-way acquisition, some interim agreement should be developed regarding the responsibility of maintenance. This would be especially relevant should further studies recommend drawdown of the lake with its possible environmentally objectionable reactions by the surrounding neighborhood.

a. Alternatives

- The downstream edge of the splash apron should be protected (at least temporarily) by dumping riprap rock into the stilling basin.

- The undermined apron should be backfilled and/or pressure grouted.

- The eroded areas between the wingwalls should be refilled and protected with slope protection.

- The sluice gate should be repaired and its entrance cleared of debris and silt.

- The major cracks in the concrete should be patched.

- As previously stated, consideration could be given to removing the dam.

b. O&M Maintenance and Procedures

The owners should institute O&M procedures in conjunction with Municipal and State Authorities and develop checklists for periodic inspections and record keeping.

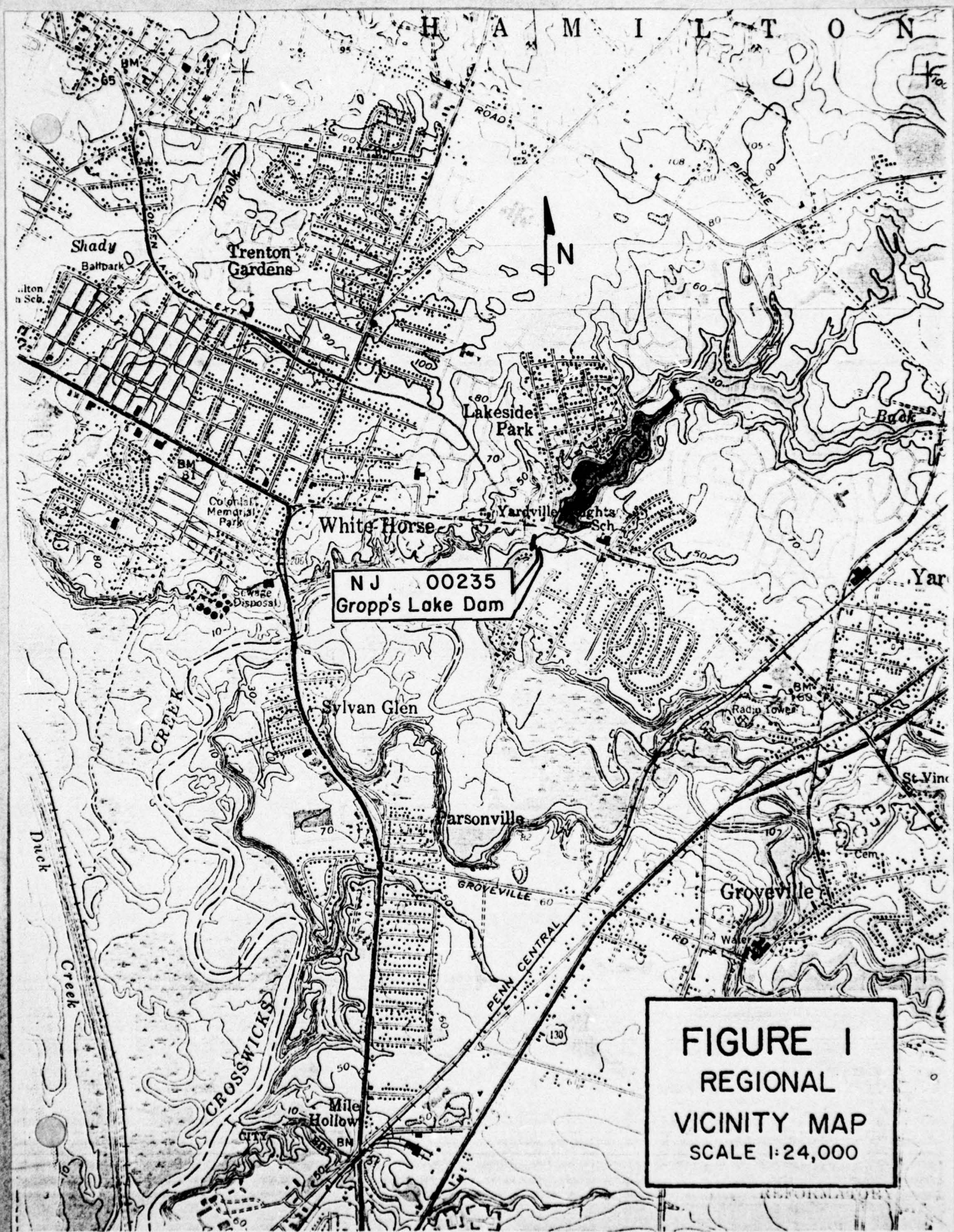
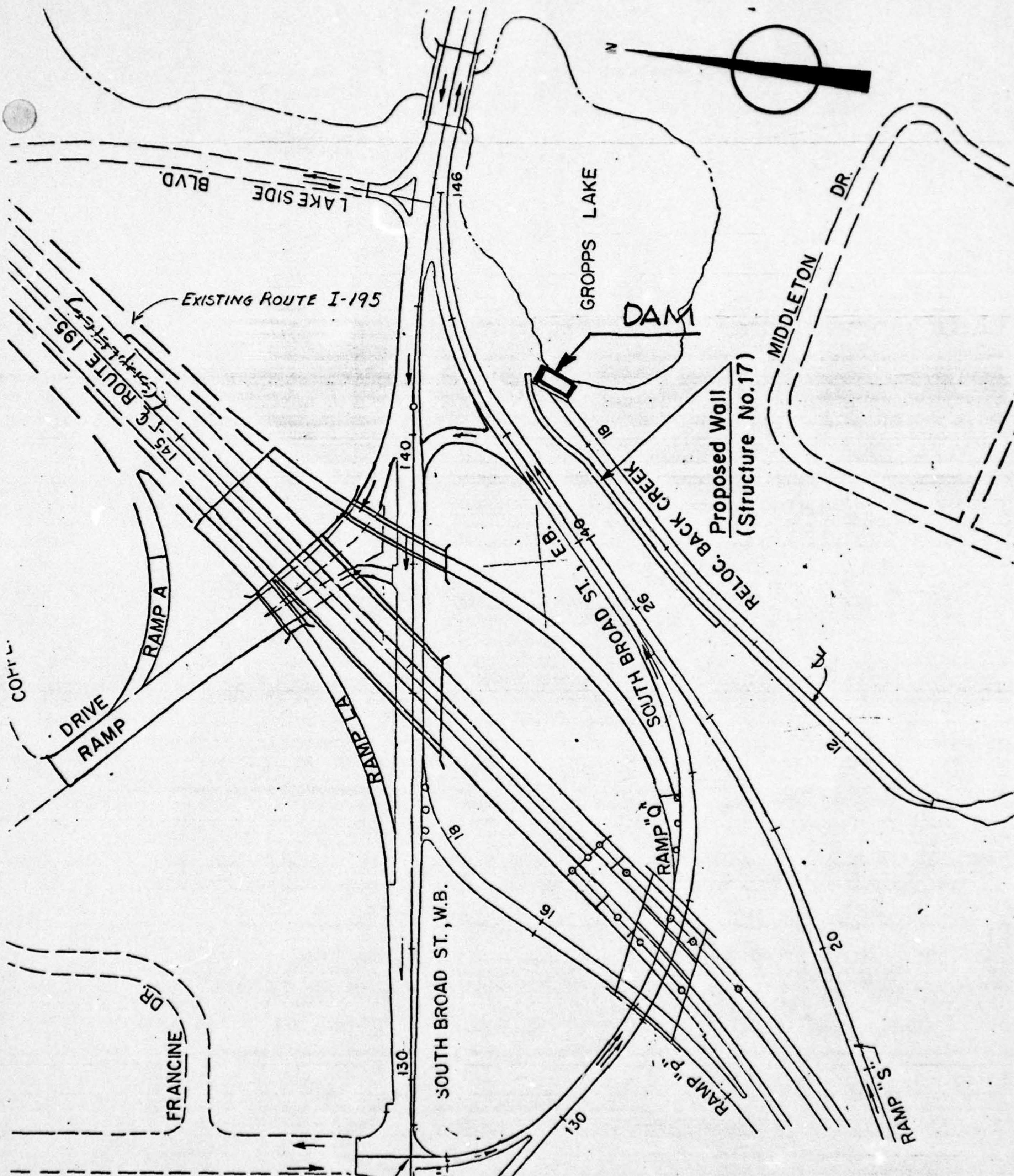
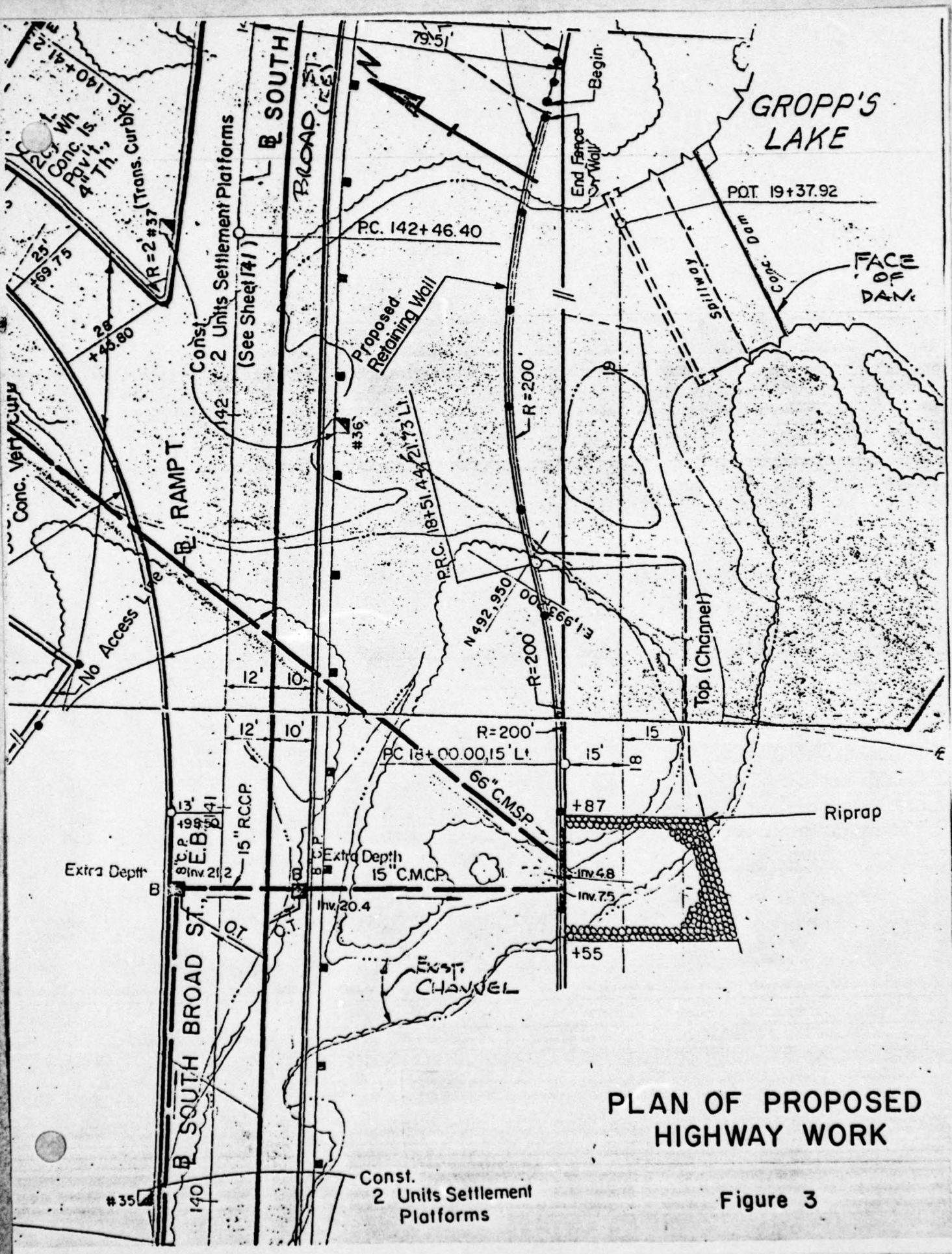


FIGURE 1
REGIONAL VICINITY MAP
SCALE 1:24,000



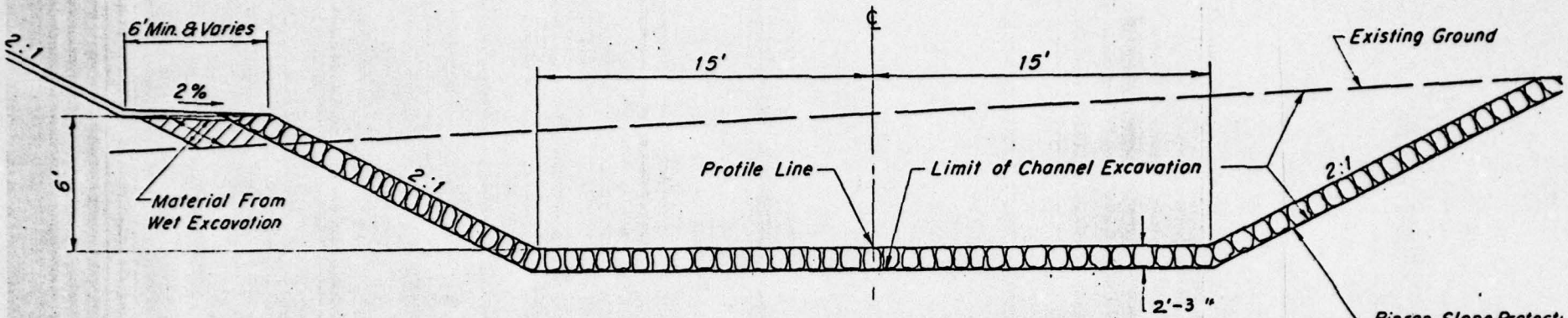
PROPOSED I-195 INTERCHANGE LAYOUT

Figure 2

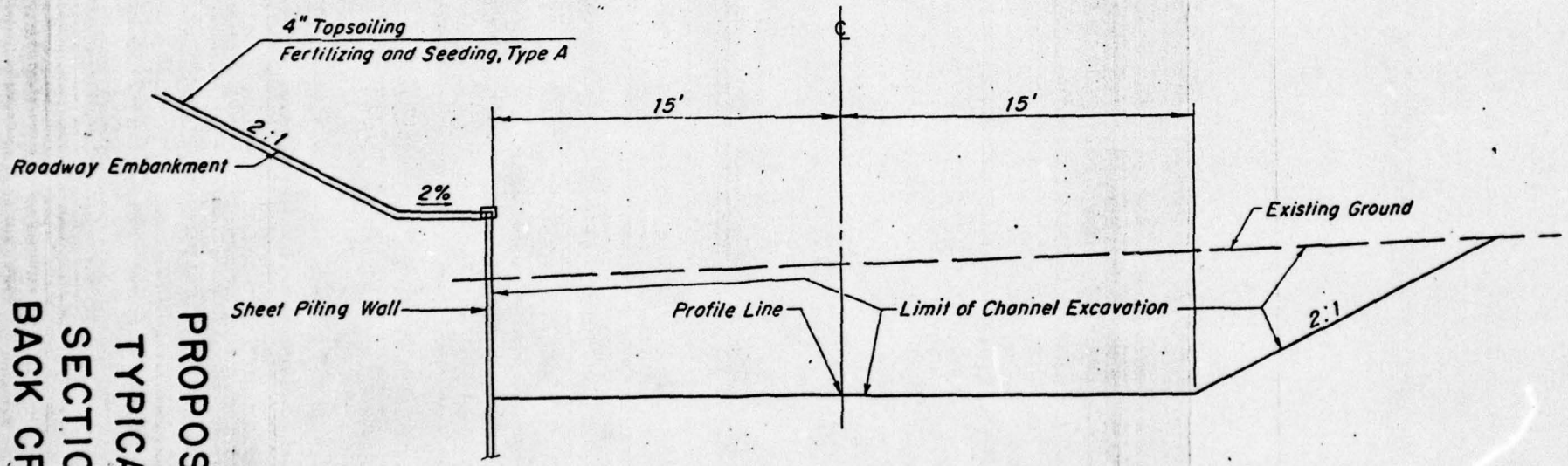


PLAN OF PROPOSED HIGHWAY WORK

Figure 3



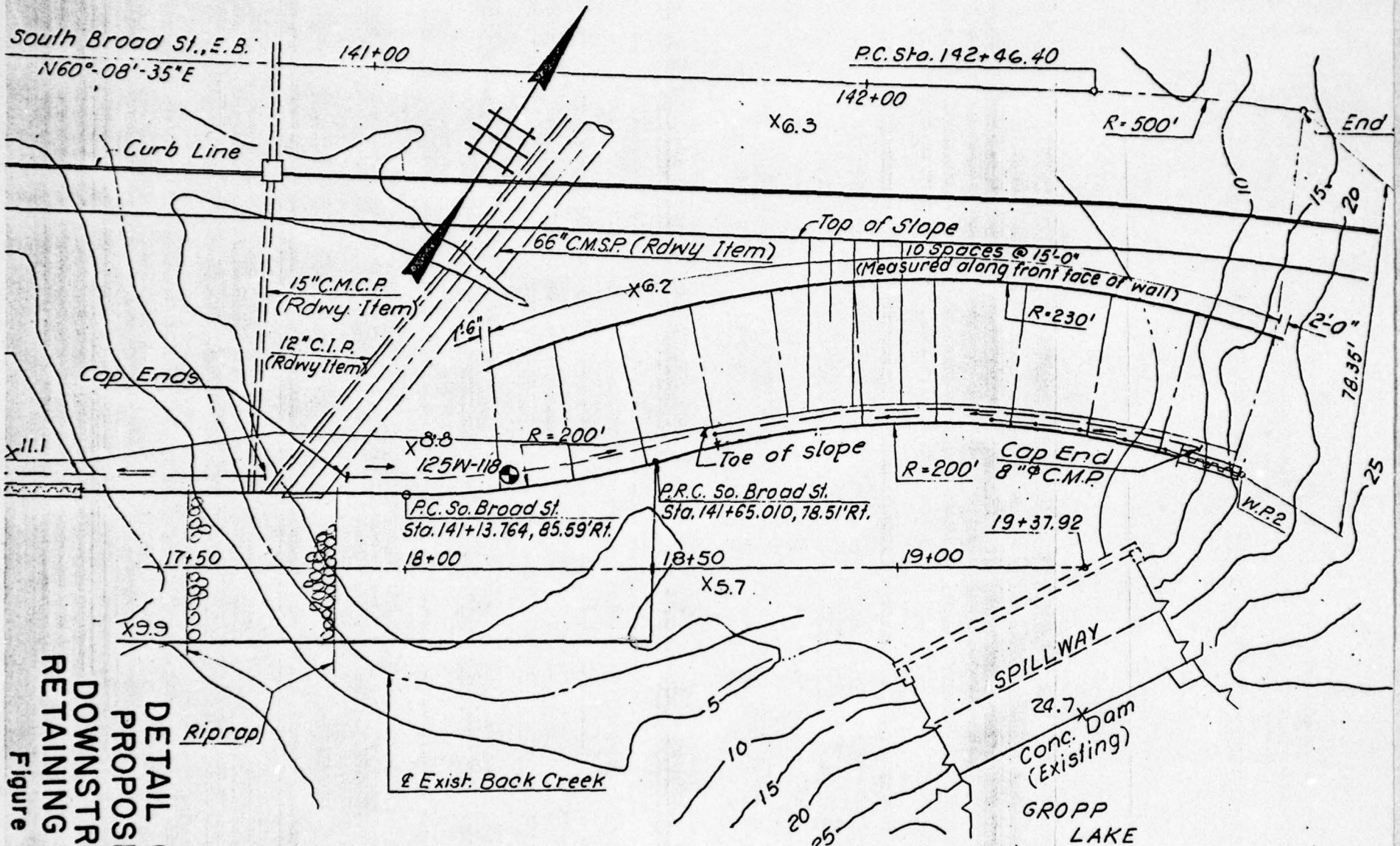
RELOCATED BACK CREEK
STA. 9+00 TO STA. 14+00
Scale: 1"=5'



RELOCATED BACK CREEK
STA. 14+50 TO STA. 19+70 ± (AREA IMMEDIATELY BELOW DAM)
Scale: 1"=5'

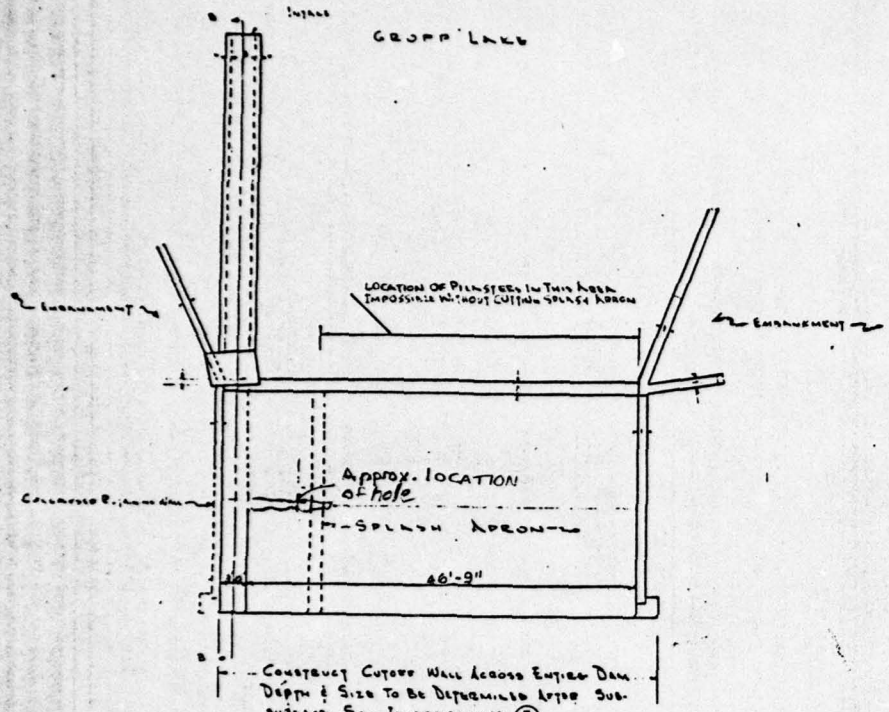
PROPOSED
TYPICAL
SECTIONS
BACK CREEK

Figure 4

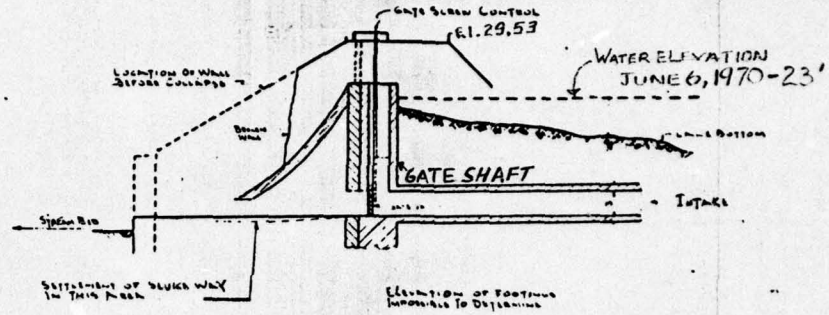


DETAIL OF PROPOSED DOWNSTREAM RETAINING WALL

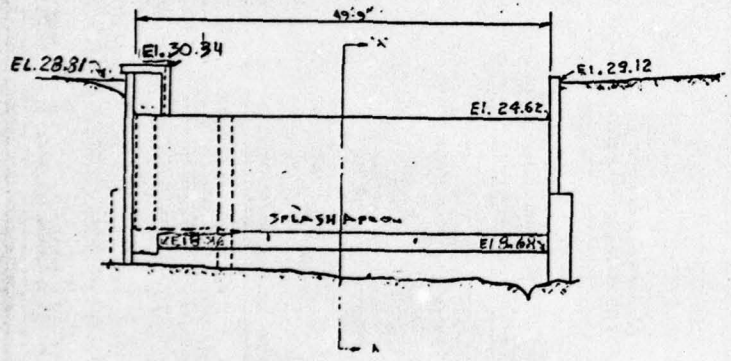
Figure 5



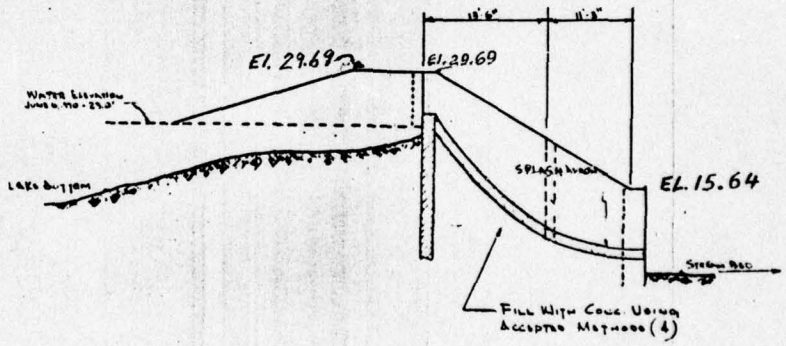
PLAN



SECTION B-B



FRONT ELEVATION



SECTION A-A

DETAILS OF SPILLWAY

Figure 6

Check List
Visual Inspection
Phase 1

Name Dam Gropps Lake Dam County Mercer State New Jersey Coordinators NJDEP

Date(s) Inspection 1/5,11/79 Weather Overcast Temperature 22°F

Pool Elevation at Time of Inspection 25 M.S.L. Tailwater at Time of Inspection 6 M.S.L.

Inspection Personnel:

T. Chapter K. Jolls

L. Baines

E. Simone

T. Chapter Recorder

Dam No. 00235

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
LEAKAGE	None observed, but entire apron undermined.	
STRUCTURE TO ABUTMENT/EMBANKMENT JUNCTIONS	Right Junction - Sloughing behind structure wall Embankment completely eroded away Left Junction - Mass erosion behind wingwall Column at foot of left wingwall undermined Structural cracks on both sidewalls	
DRAINS	None observed	
WATER PASSAGES	Gate housing eroded away at water line	
FOUNDATION	Apron undermined at toe and head where it has separated from spillway	

CONCRETE/MASONRY DAMS

VISUAL EXAMINATION OF	OBERSVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS CONCRETE SURFACES	Surface spalling and cracking common over entire structure. Massive concrete deterioration on right wingwall, left foot wall, and splash surface of spillway.	
STRUCTURAL CRACKING	2" wide vertical crack on left side wall. Bottom half of right wingwall collapsed. Separation of right wingwall and retaining wall.	Vertical crack between left wingwall and retaining wall. Right wingwall lying in stilling pond.
VERTICAL AND HORIZONTAL ALIGNMENT	Movement of right wall away from spillway.	Poor. Downstream apron undercut and failure imminent.
MONOLITH JOINTS	N/A	
CONSTRUCTION JOINTS	Poor condition.	Joints have all failed.

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SURFACE CRACKS	Cracks approximately 4' deep in right embankment. Sloughing behind right wingwall and right retaining wall.	
UNUSUAL MOVEMENT OR CRACKING AT OR BEYOND THE TOE	Downstream toe just below right wingwall completely washed out into stilling basin.	
SLOUGHING OR EROSION OF EMBANKMENT AND ABUTMENT SLOPES	Large scale erosion behind both wingwalls. 4' deep ruts on right embankment. Entire slope deeply eroded. Deep erosion channel (re-entrant) below left embankment.	
VERTICAL AND HORIZONTAL ALINEMENT OF THE CREST	Left embankment completely overgrown with large diameter trees (approximately 20"ø). Large trees on right embankment show signs of creep and movement.	
RIPRAP FAILURES	N/A	

EMBANKMENT

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
JUNCTION OF EMBANKMENT AND ABUTMENT, SPILLWAY AND DAM	Deep erosion of embankment behind both wingwalls. Parking lot on right embankment. Downslope used as garbage dump.	
ANY NOTICEABLE SEEPAGE	Steady seepage at foot of left re-entrant carrying silt to pond. Lighter seepage at toe of right embankment.	
STAFF GAGE AND RECORDER	None observed.	
DRAINS	None	

OUTLET WORKS

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CRACKING AND SPALLING OF CONCRETE SURFACES IN OUTLET CONDUIT	Concrete casing around stem eroded at water line.	
INTAKE STRUCTURE	No controls present, only stem.	Gate inoperable.
OUTLET STRUCTURE	N/A	
OUTLET CHANNEL	Debris laden - overgrown and choked with garbage and sedimentation. Construction garbage dump situated on stilling pond.	
EMERGENCY GATE		

UNGATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE WEIR	Appears satisfactory on surface. About 20" wide at crest.	
APPROACH CHANNEL	Main lake reservoir.	
DISCHARGE CHANNEL	Filled with debris and broken concrete.	
BRIDGE AND PIERS	Upstream bridge on Route 206 has low head room (4 feet) above normal reservoir pool.	Bridge appears to have adequate hydraulic capacity.

GATED SPILLWAY

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONCRETE SILL	N/A	
APPROACH CHANNEL	N/A	
DISCHARGE CHANNEL	N/A	
BRIDGE AND PIERS	N/A	
GATES AND OPERATION EQUIPMENT	N/A	

INSTRUMENTATION

VISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
MONUMENTATION/SURVEYS	None	
OBSERVATION WELLS	None	
WEIRS	None	
PIEZOMETERS	None	
OTHER	None	

RESERVOIR

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
SLOPES	Steep and high on left with numerous homes lining banks. Right bank not as high. Road bridge about 200' yards above spillway. Parking lot on right embankment. Slopes undercut around perimeter.	Homes back a sufficient distance from natural embankment crest to be safe if slides occur.
SEDIMENTATION	Heavy in downstream pond. None visible above dam.	Dewatering could affect Interstate drainage system of I-195.

DOWNSTREAM CHANNEL

VISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
CONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	Garbage, trees, growth, concrete, etc. choking downstream channel.	
SLOPES	Very steep and high with homes along top of left wall. Mature trees throughout entire area.	Right bank to be protected in future by I-195 construction (see Section 2A of DOT road plans).
APPROXIMATE NO. OF HOMES AND POPULATION	No homes in flood plain.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

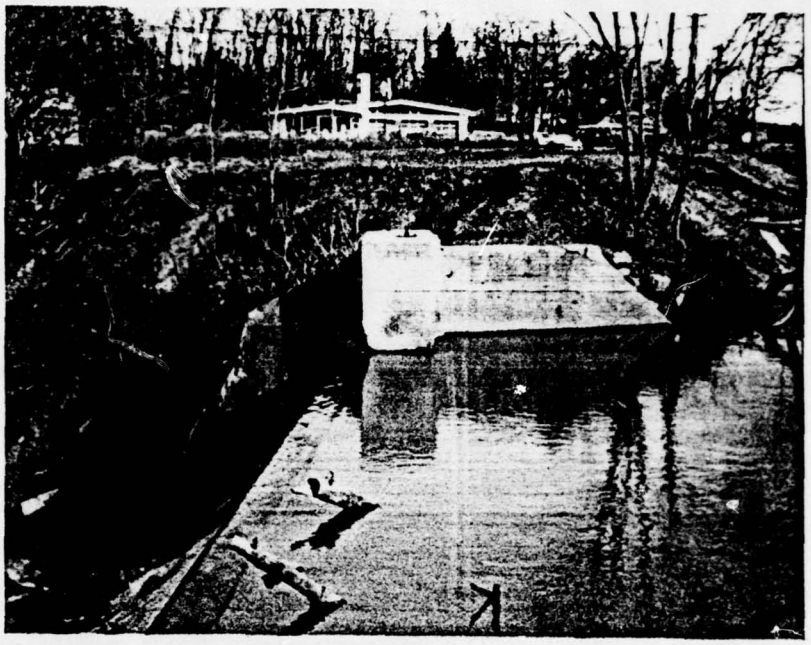
ITEM	REMARKS
PLAN OF DAM	Available (From Hamilton Township)
REGIONAL VICINITY MAP	Available (USGS Quad.)
CONSTRUCTION HISTORY	Not available
TYPICAL SECTIONS OF DAM	Available (*)
HYDROLOGIC/HYDRAULIC DATA	Not available
OUTLETS - PLAN	Available (*)
- DETAILS	Not available
-CONSTRAINTS	Not available
-DISCHARGE RATINGS	Not available
RAINFALL/RESERVOIR RECORDS	Not available

* (Available from Hamilton Township)

ITEM	REMARKS
DESIGN REPORTS	Not available
GEOLOGY REPORTS	Not available
DESIGN COMPUTATIONS	Not available
HYDROLOGY & HYDRAULICS	Not available
DAM STABILITY	Not available
SEEPAGE STUDIES	Not available
MATERIALS INVESTIGATIONS	Not available
BORING RECORDS	Not available
LABORATORY	Not available
FIELD	Not available
POST-CONSTRUCTION SURVEYS OF DAM	Available (*)
BORROW SOURCES	Not available

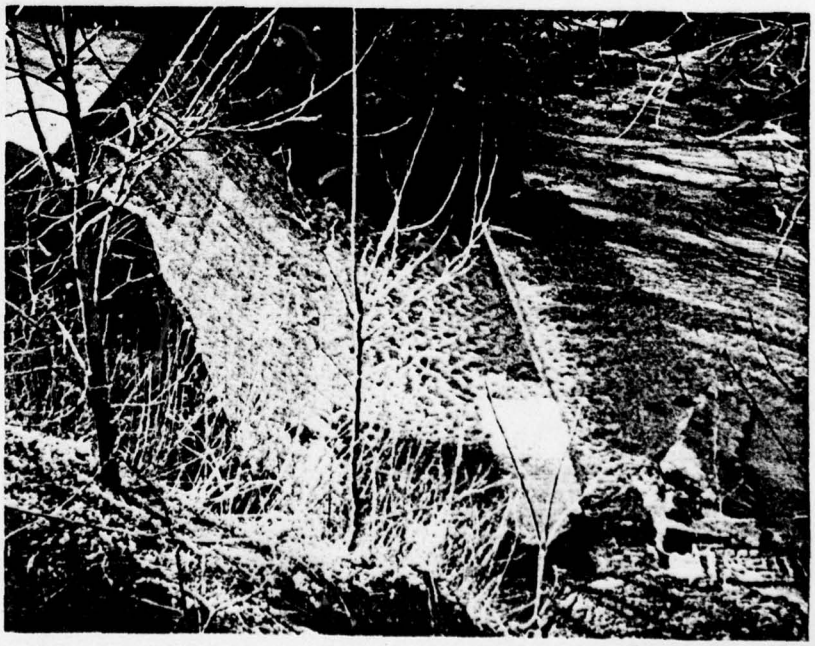
ITEM	REMARKS
MONITORING SYSTEMS	None
MODIFICATIONS	None
HIGH POOL RECORDS	Not available
POST CONSTRUCTION ENGINEERING STUDIES AND REPORTS	Repair plans available (proposed work)
PRIOR ACCIDENTS OR FAILURE OF DAM	Available (DEP)
DESCRIPTION	Not available
REPORTS	Not available
MAINTENANCE	None available
OPERATION	None available
RECORDS	None available

ITEM	REMARKS
SPILLWAY PLAN	Available (*)
SECTIONS	Available (*)
DETAILS	Available (*)
OPERATING EQUIPMENT PLANS & DETAILS	None



December, 1978

View of crest looking North East



December, 1978

View of splash apron

December, 1978

Downstream channel

December, 1978

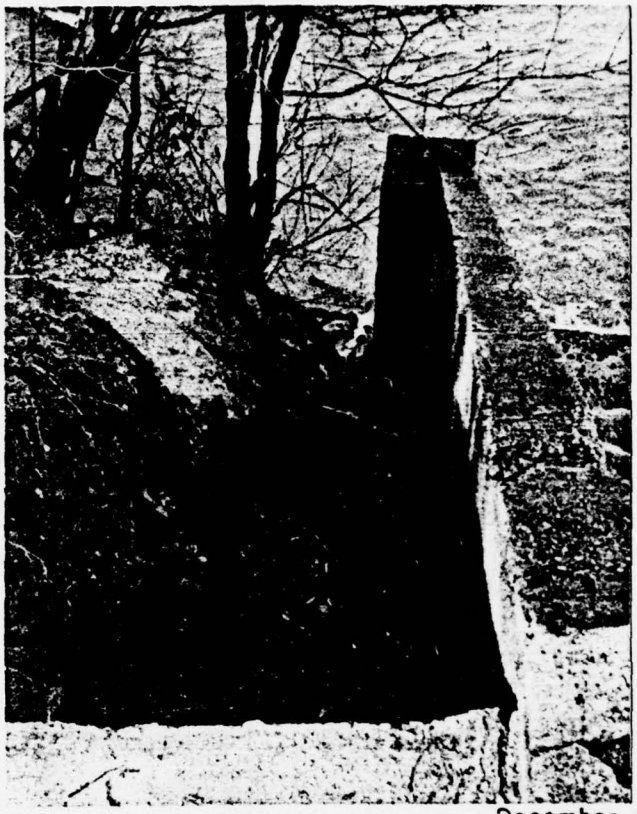
Bridge upstream from dam

December, 1978

Crest of left embankment

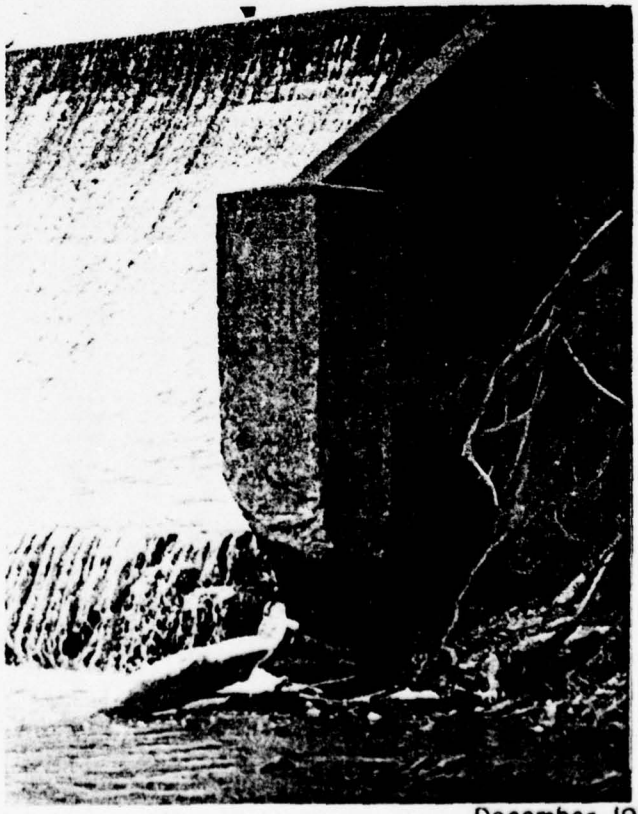
December, 1978

Seepage behind left embankment



December, 1978

Erosion behind left wingwall structure

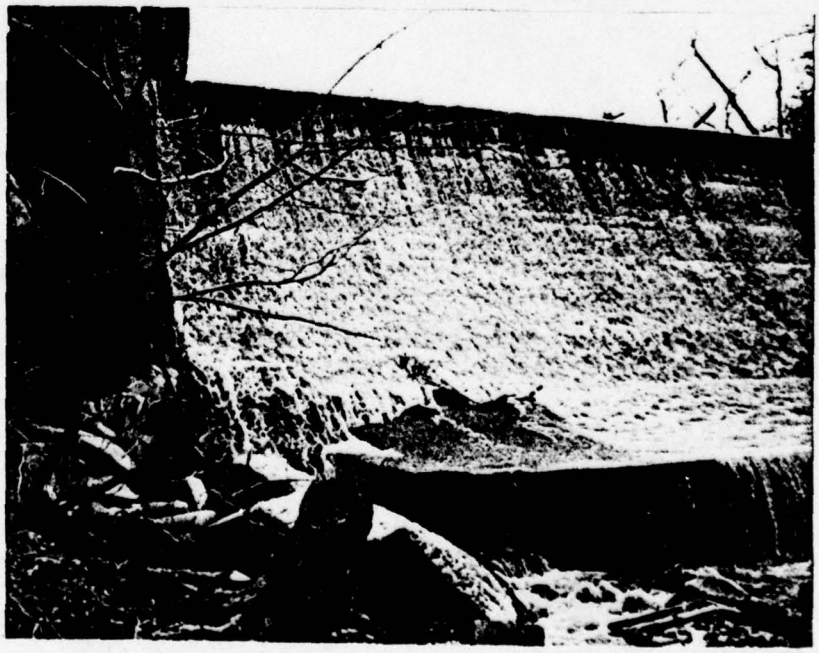


December, 1978

Undermining of left wingwall structure

December 1978

Erosion of right embankment



December 1978

Undermining and separation of splash apron

December, 1978

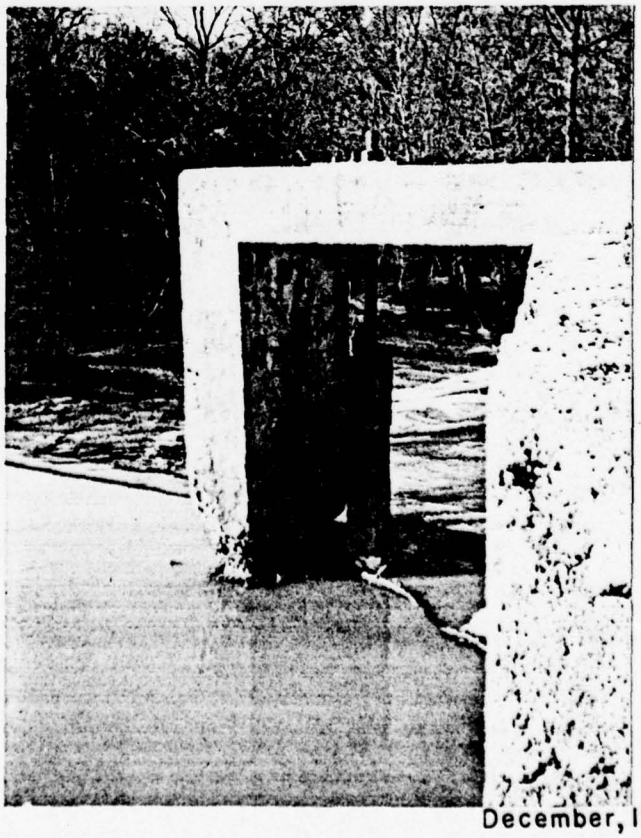
Structural cracking at juncture of left wingwall and abutment

December, 1978

Sloughing and structural cracking at right wingwall

December, 1978

Deterioration of right wingwall structure



December, 1978

Deterioration of floodgate structure

Dam No. 00235

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: 7.95 sq.mi.

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 24.6 MSL (211 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): 29.7 MSL (549 acre-feet)

ELEVATION MAXIMUM DESIGN POOL: Unknown

ELEVATION TOP DAM: 29.7 MSL

CREST:

a. Elevation 24.6 MSL
b. Type Narrow crested weir with splash apron
c. Width 1.5 feet
d. Length 49 feet (effective)
e. Location Spillover Center of dam
f. Number and Type of Gates 1-36" dia. RCP

OUTLET WORKS:

a. Type 3' dia. gate operated sluice
b. Location Right end of spillway
c. Entrance inverts 8.8 MSL
d. Exit inverts 8.2 MSL
e. Emergency draindown facilities None

HYDROMETEOROLOGICAL GAGES: None

a. Type
b. Location
c. Records

MAXIMUM NON-DAMAGING DISCHARGE: 1900 CFS (See Section 5)

BY D.J.M DATE 1-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A1 OF.
CHKD. BY DATE (GROPPS LAKE DAM INSPECTION) PROJECT C227
SUBJECT

Length of longest watercourse = 5.23 miles
difference in Elevation = 75.00

Time of concentration

CALIFORNIA CULVERTS METHOD

$$T_c = \left(\frac{11.9 \times 5.23^3}{75}\right)^{0.385}$$

$= 3.33$ hours

U.S. NAVY METHOD (Page 46 D. OF S. D.)

$$\text{Slope} = \frac{75 \times 100}{27\,600} = 0.3\%$$

Take $V = 2.0 \text{ ft s}^{-1}$

$$T = \frac{27{,}600}{2 \times 3600} = 3.8 \text{ hours}$$

overland flow negligible $\therefore T_c = 3.8$ hours

Take average $T_c = 3.4$ hours

BY D.J.M. DATE 1-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A2 OF.
CHKD. BY DATE GROPPS LAKE DAM INSPECTION PROJECT C-227
SUBJECT

$T_p = \frac{0.5}{2} + 0.6\,T_c$ = 2.29 hours

$Q_p = \frac{484 \times 8.0 \times 1.0}{2.29} \approx 1691$

T	T/Tp	Dimensionless Ordinate (D.O)	Qp x DO
0.5	0.22	0.09	152
1.0	0.44	0.34	575
1.5	0.66	0.70	1184
2.0	0.87	0.94	1590
2.5	1.09	0.97	1640
3.0	1.31	0.83	1404
3.5	1.53	0.63	1065
4.0	1.75	0.45	761
4.5	1.97	0.335	566
5.0	2.18	0.248	419
5.5	2.40	0.180	304
6.0	2.62	0.126	213
6.5	2.84	0.0934	158
7.0	3.06	0.0703	119
7.5	3.28	0.0537	90
8.0	3.49	0.0368	62
8.5	3.71	0.0284	48
9.0	3.93	0.0206	35
9.5	4.15	0.0153	26
10.0	4.37	0.0113	19

20 ORDINATES

BY D. J. M. DATE 3-79
CHKD. BY _____ DATE _____
SUBJECT _____

LOUIS BERGER & ASSOCIATES INC.
GROPPS LAKE DAM INSPECTION

SHEET NO. A3 OF
PROJECT C227

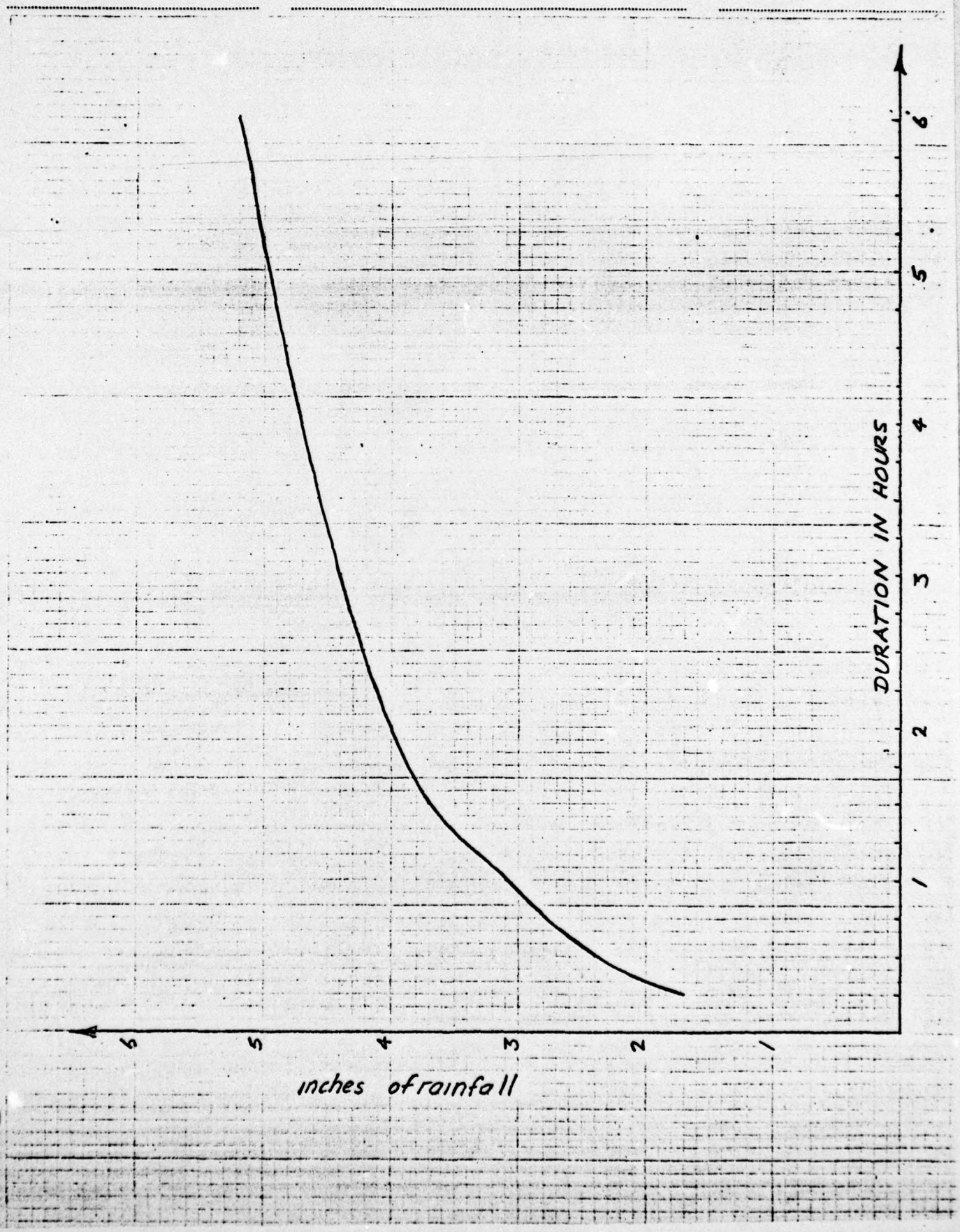
Precipitation data from T.P. 40 & N.W.S - HYDRO 35
(See depth duration curve overleaf)

Time	Precipitation	Δ	Rearrange Δ
0.5	2.40	2.40	0.12
1.0	3.10	0.70	0.12
1.5	3.70	0.60	0.14
2.0	4.00	0.30	0.17
2.5	4.22	0.22	0.18
3.0	4.40	0.18	0.22
3.5	4.57	0.17	0.70
4.0	4.71	0.14	2.40
4.5	4.84	0.13	0.60
5.0	4.96	0.12	0.30
5.5	5.08	0.12	0.13
6.0	5.20	0.12	0.12

BY D.J.M DATE 1-79
CHKD. BY ..... DATE .....

SUBJECT T.P. 40 & NWS HYDRO 35
DEPTH DURATION CURVE

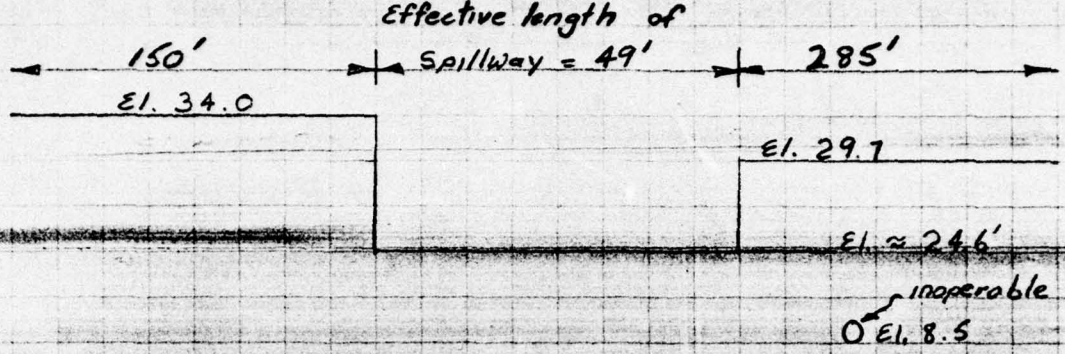
SHEET NO. A4 OF .....
JOB NO. C227



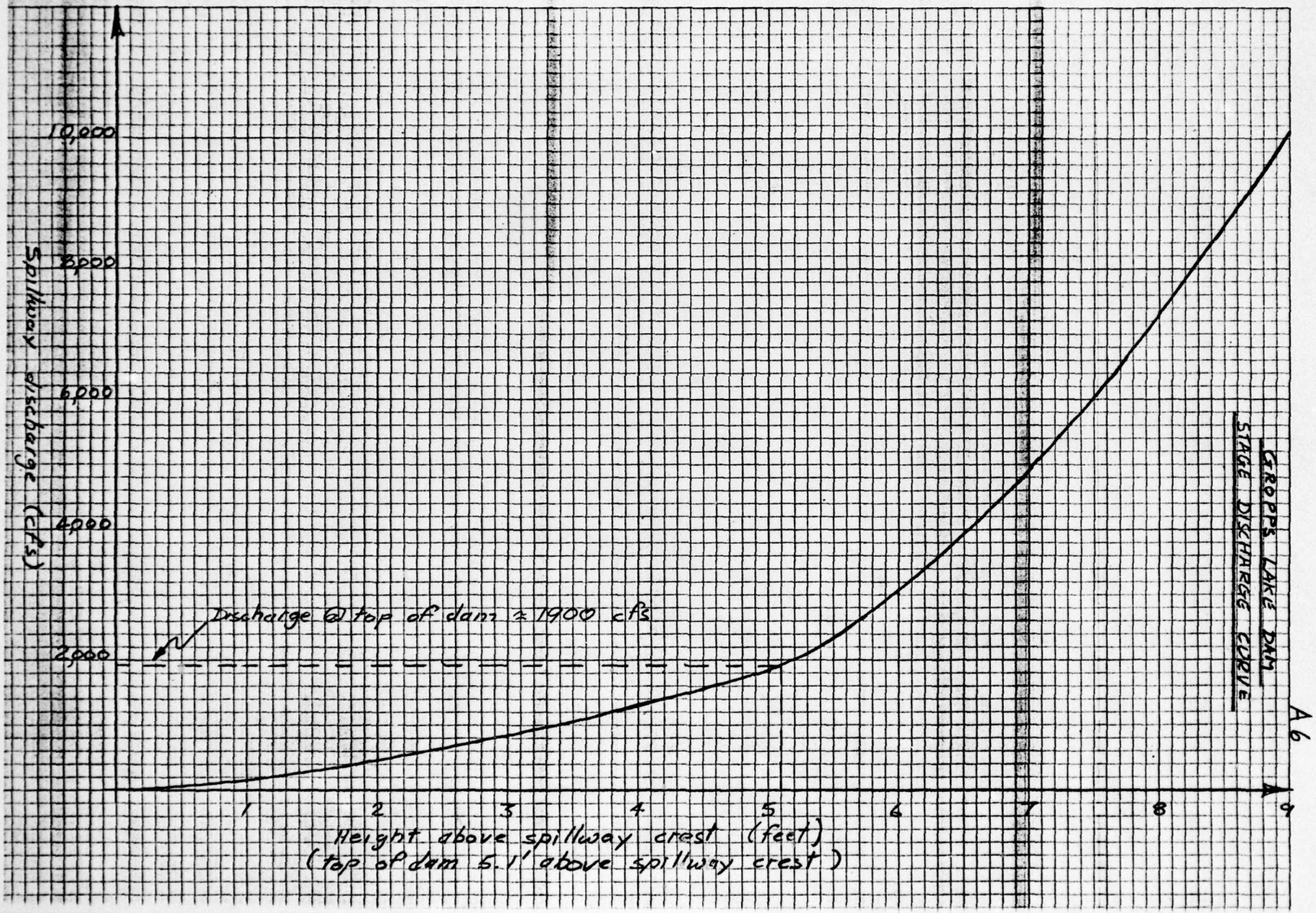
BY D. J. M. DATE 1-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A5 OF

CHKD. BY ____ DATE ____ GROPPS LAKE DAM INSPECTION PROJECT C227

SUBJECT Spillway discharge capacity



Flow over spillway L = 49'			Flow over dam left L = 150'			Flow over dam right L = 285'			ΣQ
H	C	Q	H	C	Q	H	C	Q	
1	3.3	162							162
2	3.3	457							457
3	3.3	840							840
4	3.3	1294							1294
5	3.3	1808							1808
6	3.3	2376				0.9	2.6	633	3009
7	3.3	2995				1.9	2.6	1941	4936
8	3.3	3659				2.9	2.6	3659	7318
9	3.3	4366				3.9	2.6	5707	10073
10	3.3	5115				4.9	2.6	8037	13150



A-6

BY D.J.M DATE 1-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A7 OF.

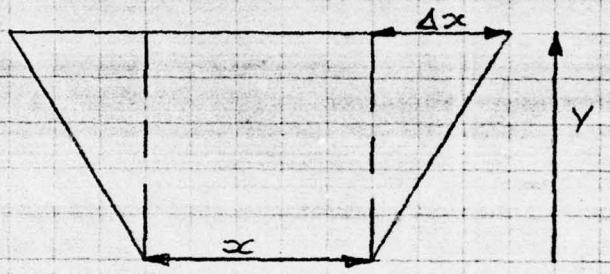
CHKD. BY DATE GROPPS LAKE DAM INSPECTION PROJECT C277

SUBJECT SURCHARGE STORAGE

AREA OF LAKE @ El. 24.6 ≈ 41 acres

AREA OF CONTOUR @ El. 30.0 ≈ 98.5 acres

AREA OF CONTOUR @ El. 40.0 ≈ 156 acres

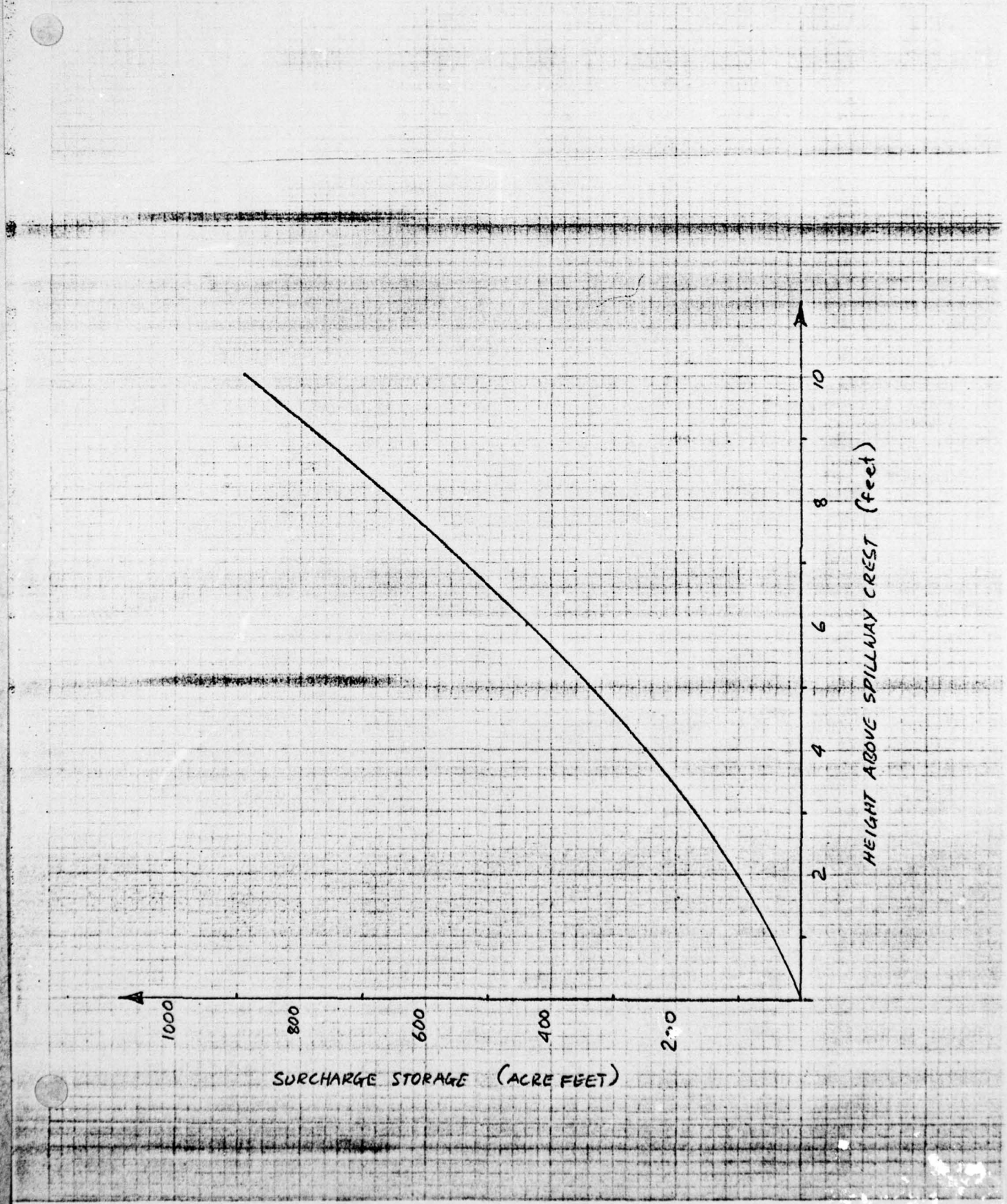


HEIGHT ABOVE Spillway crest (feet)	SURCHARGE STORAGE (acre feet)
1	46
2	103
3	171
4	249
5	338
6	437
7	542
8	652
9	769
10	891

BY D. J. M DATE 1-79
CHKD. BY ..... DATE .....

SUBJECT STAGE STORAGE CURVE
GROPPS LAKE DAM INSPECTION

SHEET NO. A8 OF .....
JOB NO. C227



BY D.J.M. DATE 3-79 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. A9 OF.
CHKD. BY _____ DATE _____ GROPPS LAKE DAM INSPECTION PROJECT C227
SUBJECT _____

Top of dam = +29.7 ±

Surcharge storage @ top of dam = 338 acre feet
normal pool storage = 211 " "

∴ total storage @ top of dam = 549 acre feet

Max non damaging discharge = 1,900 cfs
@ top of dam (El. 29.7)

length of spillway = 60'

Effective length = 49' ✓

Total length of dam = 485'

BY D.J.M. DATE 3-79
CHKD. BY ____ DATE ____
SUBJECT ____

LOUIS BERGER & ASSOCIATES INC.
GROPPS LAKE DAM INSPECTION

SHEET NO. A10 OF
PROJECT C-227

Volume of lake below spillway crest = 211 acre feet

$\approx 9,191,160$ ft^3

take total head = 16.1'

assume no tailwater but assume inflow of 2 cfs/sq mile
≈ 16 cfs

drawdown under 3 heads :- $h = 13.45'$; $8.1'$; $2.7'$.

$h = 13.45'$ $\quad Q = 0.55\, a\sqrt{64.32 \times 13.45} - 16 \approx 98$ cfs

time $= \dfrac{3063720}{98 \times 3600} = 8.7$ hours

$h = 8.1'$ $\quad Q = 0.55\, a\sqrt{64.32 \times 8.1} - 16 \approx 73$ cfs

time $= \dfrac{3063720}{73 \times 3600} = 11.7$ hours

$h = 2.7'$ $\quad Q = 0.55\, a\sqrt{64.32 \times 2.7'} - 16 \approx 35$ cfs

time $= \dfrac{3063720}{35 \times 3600} = 24.3$ hours

Σ time ≈ 45 hours

≈ 2 days

BY DJM DATE

CHKD. BY DATE

SUBJECT

LOUIS BERGER & ASSOCIATES INC.

GROPPS LAKE DAM

SHEET NO. A-11 OF

PROJECT C-227

GROPPS LAKE DAM INSPECTION NORTH GROUP C227
BY D.J.MULLIGAN
JANUARY 1979

JOB SPECIFICATION

NQ	NHR	NMIN	IDAY	IHR	IMIN	METRC	IPLT	IPRT	NSTAN
100	0	30	0	0	0	0	0	0	0

JOPER	NWT
3	0

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SUB-AREA RUNOFF COMPUTATION

INFLOW HYDROGRAPH

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
5	0	0	0	0	0	1

HYDROGRAPH DATA

IHYDG	IUHG	TAREA	SNAP	TRSDA	TRSPC	RATIO	ISNOW	ISAME	LOCAL
0	-1	8.00	0.0	8.00	0.0	0.0	0	0	0

PRECIP DATA

NP	STORM	DAJ	DAK
12	0.0	0.0	0.0

PRECIP PATTERN

0.12	0.12	0.14	0.17	0.18	0.22	0.70	2.40	0.60	0.30
0.13	0.12								

LOSS DATA

STRKR	DLTKR	RTIOL	ERAIN	STRKS	RTIOK	STRTL	CNSTL	ALSMX	RTIMP
0.0	0.0	1.00	0.0	0.0	1.00	0.50	0.10	0.0	0.0

GIVEN UNIT GRAPH, NUHGQ= 20

152.	575.	1184.	1590.	1640.	1404.	1065.	761.	566.	419.
304.	213.	158.	119.	90.	62.	48.	35.	26.	19.

UNIT GRAPH TOTALS 10430. CFS OR 1.01 INCHES OVER THE AREA

RECESSION DATA

STRTQ= 0.0 QRCSN= 0.0 RTIOR= 1.00

END-OF-PERIOD FLOW

TIME	RAIN	EXCS	COMP Q
1	0.12	0.00	0.
2	0.12	0.00	0.
3	0.14	0.00	0.
4	0.17	0.04	5.
5	0.18	0.13	40.
6	0.22	0.17	142.
7	0.70	0.65	407.
8	2.40	2.35	1197.
9	0.60	0.55	2738.
10	0.30	0.25	4669.

BY D.J.M. DATE

CHKD. BY DATE

SUBJECT

LOUIS BERGER & ASSOCIATES INC.

GROPPS LAKE DAM

SHEET NO. A-12 OF.

PROJECT

11	0.13	0.08	6014.
12	0.12	0.07	6294.
13	0.0	0.0	5644.
14	0.0	0.0	4581.
15	0.0	0.0	3454.
16	0.0	0.0	2599.
17	0.0	0.0	1928.
18	0.0	0.0	1406.
19	0.0	0.0	1008.
20	0.0	0.0	740.
21	0.0	0.0	550.
22	0.0	0.0	409.
23	0.0	0.0	294.
24	0.0	0.0	220.
25	0.0	0.0	160.
26	0.0	0.0	116.
27	0.0	0.0	76.
28	0.0	0.0	23.
29	0.0	0.0	9.
30	0.0	0.0	3.
31	0.0	0.0	1.
32	0.0	0.0	0.
33	0.0	0.0	0.
34	0.0	0.0	0.
35	0.0	0.0	0.
36	0.0	0.0	0.
37	0.0	0.0	0.
38	0.0	0.0	0.
39	0.0	0.0	0.
40	0.0	0.0	0.
41	0.0	0.0	0.
42	0.0	0.0	0.
43	0.0	0.0	0.
44	0.0	0.0	0.
45	0.0	0.0	0.
46	0.0	0.0	0.
47	0.0	0.0	0.
48	0.0	0.0	0.
49	0.0	0.0	0.
50	0.0	0.0	0.
51	0.0	0.0	0.
52	0.0	0.0	0.
53	0.0	0.0	0.
54	0.0	0.0	0.
55	0.0	0.0	0.
56	0.0	0.0	0.
57	0.0	0.0	0.
58	0.0	0.0	0.
59	0.0	0.0	0.
60	0.0	0.0	0.
61	0.0	0.0	0.
62	0.0	0.0	0.
63	0.0	0.0	0.
64	0.0	0.0	0.
65	0.0	0.0	0.
66	0.0	0.0	0.
67	0.0	0.0	0.
68	0.0	0.0	0.
69	0.0	0.0	0.
70	0.0	0.0	0.
71	0.0	0.0	0.
72	0.0	0.0	0.
73	0.0	0.0	0.
74	0.0	0.0	0.
75	0.0	0.0	0.
76	0.0	0.0	0.
77	0.0	0.0	0.
78	0.0	0.0	0.
79	0.0	0.0	0.
80	0.0	0.0	0.

81	0.0	0.0	0.
82	0.0	0.0	0.
83	0.0	0.0	0.
84	0.0	0.0	0.
85	0.0	0.0	0.
86	0.0	0.0	0.
87	0.0	0.0	0.
88	0.0	0.0	0.
89	0.0	0.0	0.
90	0.0	0.0	0.
91	0.0	0.0	0.
92	0.0	0.0	0.
93	0.0	0.0	0.
94	0.0	0.0	0.
95	0.0	0.0	0.
96	0.0	0.0	0.
97	0.0	0.0	0.
98	0.0	0.0	0.
99	0.0	0.0	0.
100	0.0	0.0	0.
SUM	5.20	4.29	44697.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	6294.	3458.	931.	447.	44696.
INCHES		4.02	4.33	4.33	4.33
AC-FT		1716.	1848.	1848.	1848.

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HYDROGRAPH ROUTING

ROUTING THROUGH RESERVOIR

ISTAQ	ICOMP	IECON	ITAPE	JPLT	JPRT	INAME
55	1	0	0	0	0	1

ROUTING DATA

QLOSS	CLOSS	AVG	IRES	ISAME
0.0	0.0	0.0	1	0

NSTPS	NSTDL	LAG	AMSKK	X	TSK	STORA
1	0	0	0.0	0.0	0.0	0.

STORAGE=	0.	46.	103.	171.	249.	338.	437.	542.	652.	769.
OUTFLOW=	0.	152.	457.	840.	1294.	1808.	3009.	4936.	7318.	10073.

TIME	EOP STOR	AVG IN	EOP OUT
1	0.	0.	0.
2	0.	0.	0.
3	0.	0.	0.
4	0.	5.	0.

BY DJM DATE

CHKD. BY DATE

SUBJECT

LOUIS BERGER & ASSOCIATES INC.

GROPPS LAKE DAM

SHEET NO. A-14 OF

PROJECT C-227

5	1.	23.	3.
6	4.	91.	15.
7	14.	274.	50.
8	43.	802.	152.
9	111.	1967.	502.
10	229.	3703.	1179.
11	378.	5341.	2296.
12	499.	6154.	4152.
13	553.	5969.	5178.
14	551.	5097.	5128.
15	518.	4002.	4488.
16	474.	3027.	3684.
17	431.	2264.	2932.
18	389.	1667.	2425.
19	349.	1207.	1937.
20	311.	874.	1650.
21	274.	645.	1436.
22	238.	479.	1231.
23	206.	351.	1042.
24	177.	257.	874.
25	151.	190.	730.
26	130.	138.	607.
27	111.	96.	500.
28	94.	49.	410.
29	79.	16.	334.
30	67.	6.	271.
31	57.	2.	219.
32	49.	1.	177.
33	42.	0.	148.
34	36.	0.	128.
35	31.	0.	111.
36	27.	0.	96.
37	24.	0.	83.
38	20.	0.	72.
39	18.	0.	62.
40	15.	0.	53.
41	13.	0.	46.
42	11.	0.	40.
43	10.	0.	35.
44	8.	0.	30.
45	7.	0.	26.
46	6.	0.	22.
47	5.	0.	19.
48	5.	0.	17.
49	4.	0.	14.
50	4.	0.	12.
51	3.	0.	11.
52	3.	0.	9.
53	2.	0.	8.
54	2.	0.	7.
55	2.	0.	6.
56	1.	0.	5.
57	1.	0.	4.
58	1.	0.	4.
59	1.	0.	3.
60	1.	0.	3.
61	1.	0.	3.
62	1.	0.	2.
63	1.	0.	2.
64	0.	0.	2.
65	0.	0.	1.

BY DJM DATE

CHKD. BY DATE

SUBJECT

LOUIS BERGER & ASSOCIATES INC.

GROPPS LAKE DAM

SHEET NO. A-15 OF

PROJECT C-227

66	0.	0.	1.
67	0.	0.	1.
68	0.	0.	1.
69	0.	0.	1.
70	0.	0.	1.
71	0.	0.	1.
72	0.	0.	1.
73	0.	0.	0.
74	0.	0.	0.
75	0.	0.	0.
76	0.	0.	0.
77	0.	0.	0.
78	0.	0.	0.
79	0.	0.	0.
80	0.	0.	0.
81	0.	0.	0.
82	0.	0.	0.
83	0.	0.	0.
84	0.	0.	0.
85	0.	0.	0.
86	0.	0.	0.
87	0.	0.	0.
88	0.	0.	0.
89	0.	0.	0.
90	0.	0.	0.
91	0.	0.	0.
92	0.	0.	0.
93	0.	0.	0.
94	0.	0.	0.
95	0.	0.	0.
96	0.	0.	0.
97	0.	0.	0.
98	0.	0.	0.
99	0.	0.	0.
100	0.	0.	0.
SUM			44695.

	PEAK	6-HOUR	24-HOUR	72-HOUR	TOTAL VOLUME
CFS	5178.	3045.	930.	447.	44695.
INCHES		3.54	4.33	4.33	4.33
AC-FT		1511.	1846.	1848.	1848.

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RUNOFF SUMMARY; AVERAGE FLOW

		PEAK	6-HOUR	24-HOUR	72-HOUR	AREA
HYDROGRAPH AT	5	6294.	3458.	931.	447.	8.00
ROUTED TO	55	5178.	3045.	930.	447.	8.00